

# ASTRONAUTICAL ENGINEER

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## **FLEXIBLE MULTIBODY DYNAMICS AND CONTROL OF THE BIFOCAL RELAY MIRROR**

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In recent years, spacecraft have become increasingly flexible. The design requirements for the Bifocal Relay Mirror spacecraft include controlling jitter at the nanoradian level. Typically, tight pointing requirements require high structural stiffness, at the cost of increasing the on-orbit mass. To accomplish this, while minimizing the mass of the spacecraft, the structure will have some inherent flexibility. These flexible modes will interact with the pointing control, hence affecting the payload performance. The compensator design conducted in this thesis achieves order of magnitude improvements in controlling the rate error, hence jitter. This thesis starts with a rigid body dynamic model, and develops a flexible body dynamic model. Once the model is developed, the structure-controls interaction is discussed. Finally, compensators are applied to the rigid body controller to mitigate the performance losses present in the flexible body system. Through classical second-order compensators, the angular rate error was decreased by a factor of ten. Nonminimum phase notch filters and phase lag filters were used. Ultimately, the phase lag filters provided the best performance.

**KEYWORDS:** Controls, Flexible, Flexibility, Structure, Compensator, Filter, Bifocal Relay Mirror, Modal, Modes, Laser, Satellite, Spacecraft, MATLAB, SIMULINK, Attitude